DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 24 May 2011 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1, 8, 9, 11, 21, 24, 27, and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 6,411,490 to Dible in view of U.S. Patent Application Publication 2003/0056901 to Nakano et al., WO 01/95352 to Quon et al. and U.S. Patent 6,817,377 to Reimer et al. U.S. Patent Application Publication 2003/0094239 is referred to as an English language equivalent of Quon et al.

In regards to Claims 1, 8, and 11, Dible teaches a plasma processing system, comprising: a processing container 212 whose inner pressure can be reduced; a first electrode 210 arranged in the processing container, the first electrode being supplied a first high-frequency electric power and a second high frequency electric power; a

second electrode arranged in the processing container in parallel with and opposed to the first electrode (Figure 2); an enclosure 202 forming an enclosed space; and a high frequency electric power supplying part arranged in the enclosed space, wherein the high frequency electric power supplying part further comprises: a first high frequency electric power source unit 206 that outputs the first high frequency electric power having a first frequency, a first matching unit 214 for impedance matching of the first high frequency electric power, a second high frequency electric power source unit 208 that outputs the second high frequency electric power having a second frequency, a second matching unit 216 for impedance matching of the second high frequency electric power, and a transmission line that transmits the first high frequency electric power from the first high frequency electric power source unit 206 to the first matching unit 216. (See at least Figure 2; Column 5, Line 47 - Column 8, Line 61) Dible teaches that the frequency of the power supplied by the first high frequency electric power source unit 206 is higher (27 MHz) than the frequency of the power supplied by the second high frequency electric power source unit 208 (2 MHz). (Column 7, Lines 7-24)

While Dible does not expressly mention the provision of a process gas supplying part that supplies a process gas into the processing container, the presence of a process gas supplying part is implicit in the teachings of Dible to enable the generation of a plasma in the plasma processing apparatus.

Dible does not expressly teach that the enclosed space of the enclosure can be formed by a tubular supporting part that supports the first electrode and by the bottom surface of the first electrode.

Nakano et al. teaches, in a plasma processing unit, a tubular supporting part 12B supporting a first electrode 8 as broadly recited in the claims, the tubular supporting part forming an enclosed space together with a bottom surface of the first electrode 8 such that said space is disposed within the tubular supporting part 12B below the first electrode 8, and a high-frequency electric power supplying part (shaft 13) arranged in the space. (Figure 17; Paragraph 325)

It would have been obvious to one of ordinary skill in the art to modify the apparatus of Dible to alternatively form the enclosure 202 as a tubular supporting part forming an enclosed space together with the bottom surface of the first electrode 210, as suggested by the teachings of Nakano et al., for the predictable result, as would be recognized by one of ordinary skill in the art of reducing the floor space required for the apparatus (compared to the side-by-side arrangement of Dible).

In regards to Claims 1 and 11, Dible teaches wherein a power supply rod 241, as broadly recited in the claims, connects the high-frequency electric power supply part of the first electrode (Figure 2), and a coaxial cable or tube connecting the first electrode to each of the first and second match networks. (See at least Column 8, Lines 45-49)

Dible does not expressly teach wherein the first matching unit is directly connected to the power supply rod, while in contrast not just a coaxial tube but also a filter connects the first electrode to the second matching unit, the filter removing frequencies other than the frequency of the second high-frequency electric power.

Quon et al. teaches, in a plasma processing system (generically illustrated in Figure 3A), an alternative circuit arrangement (Figure 3C) for connecting first and

second high-frequency power sources 14, 16 to a first electrode 18, wherein a first high-frequency power source 14 has a higher frequency than a second high-frequency power source 16, and wherein a first matching unit 30 is directly connected to a power supply rod 21 for impedance matching of the first high-frequency electric power, while both a transmission line and a filter 39 connect the first electrode to a second matching unit 32 for impedance matching of the second high-frequency electric power, the filter removing frequencies other than the frequency of the second high-frequency electric power. (Figure 3C; Paragraph 26)

It would have been obvious to one of ordinary skill in the art to alternatively substitute the circuit arrangement of Quon et al., wherein the first matching unit is directly connected to the power supply rod, while in contrast not just a transmission line (which can be a coaxial tube as taught by Dible) but also a filter connects the first electrode to the second matching unit, the filter removing frequencies other than the frequency of the second high-frequency electric power, for the circuit arrangement of Dible, as an art-recognized equivalent circuitry for connecting first and second high-frequency power sources to an electrode, for the predictable result of maximizing power transmission while protecting both power sources.

Further in regards to Claims 1 and 11, and in regards to Claims 21 and 24, Dible teaches that the high-frequency electric power supplying part comprises at least three boxes, each box respectively containing one of the first high-frequency electric power source 206, the first matching unit 214, or the second matching unit 216. (Figure 2)

Reimer et al. suggests, in a substrate processing apparatus, that utility components (ex. pumps) can be locatable in a variety of positions with respect to the apparatus, including below the processing chamber, and can be stacked vertically to increase space efficiency. (See at least Column 4, Lines 1-10)

While Dible does not expressly teach that the three boxes of the first high-frequency electric power source and first and second matching units are vertically stacked one on another, such that the first matching unit is located just under the first electrode, and the second matching unit is located under the first matching unit, and the first matching unit is arranged closer to the first electrode than the second matching unit is to the first electrode, this arrangement (among other arrangements) is considered to be obvious to and within the skill of one of ordinary skill in the art to select to make, as a matter of design constraint in constructing the apparatus and installing it in a fixed amount of space, and for the predictable result of forming the apparatus to have a desirably small footprint. Moreover, one of ordinary skill in the art, following the suggestion of Nakano et al. (Figure 17; Paragraph 321) to form a matching unit 26 in a box below an electrode 8, and following the suggestion of Reimer et al. that utility components of a substrate processing apparatus can be locatable in a variety of positions with respect to the apparatus, including below the processing chamber, and can be stacked vertically to increase space efficiency, and taking the teachings of Dible, Nakano et al., and Reimer et al. as a whole, would have found it obvious to place the first matching unit box of Dible just below the first electrode, and the second matching unit box of Dible below the first matching unit box, for the predictable result of placing

both matching units in close proximity to the first electrode (to which they are connected) and increasing space efficiency by vertically stacking the components. It further would have been *prima facie* obvious to one of ordinary skill in the art to electrically isolate the second box containing the second matching unit from the first and third boxes, since Dible teaches that the first and second high frequency powers follow electrically isolated paths to the power supply rod. (Figure 2 of Dible)

In regards to Claim 9, Dible teaches that the first electrode 210 is used to support the substrate to be processed. (Figure 2)

Dible does not expressly teach that a vent hole is provided in the second electrode to jet out the process gas towards the first electrode.

Nakano et al. teaches, in a parallel plate plasma processing apparatus, that vent holes 7 are provided in the second electrode 4 to jet out the process gas towards the first electrode 8 holding the substrate 16 to be processed. (Figure 17)

It would have been obvious to one of ordinary skill in the art to modify the second electrode taught by Dible to provide process gas vent holes, as taught by Nakano et al., for the predictable result of showering the process gas to the substrate for uniform processing.

In regards to Claims 27 and 31, Dible does not expressly teach wherein the transmission line connecting the first high frequency electric power source unit 206 to the first matching unit 214 is a coaxial cable; i.e. tube.

Nakano et al. teaches that the transmission line 27A connecting a high frequency electric power source unit 27 to a matching unit 26 consists of a coaxial cable; i.e. tube. (Figure 17; Paragraph 323)

It would have been obvious to one of ordinary skill in the art to alternatively use a coaxial cable for the electrical connection between the first high frequency electric power source unit and the first matching unit, as taught by Nakano et al., for the predictable result of using a sturdy, readily available and art-recognized suitable electrical transmission means.

4. Claims 3 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dible in view of Nakano et al., Quon et al., and Reimer et al. as applied to Claims 1 and 11, and further in view of U.S. Patent 5,643,364 to Zhao et al.

The teachings of Dible, Nakano et al., Quon et al., and Reimer et al. were discussed above.

In regards to Claims 3 and 25, Dible does not teach that the length of the transmission line is shorter than $3\lambda/4$, λ being a wavelength of the third harmonic wave of the high-frequency electric power, and with respect to the third harmonic wave of the high-frequency power, an output terminal of the high-frequency electric power source is an electrically short-circuited end and an input terminal of the matching unit is an electrically open end.

Zhao et al. teaches a plasma processing unit (Figure 2), wherein a transmission line that transmits high-frequency power from high-frequency power generator 12" to processing container 10 is less than one eighth of the wavelength of the high-frequency

power signal in length. (Column 3, Line 61 - Column 4, Line 6). Zhao et al. further teaches that when the transmission line is short compared to one quarter of the wavelength of the high-frequency power signal, the matching unit can be connected at either end of the transmission line; i.e. the transmission line in question can run from the high-frequency power generator to the matching unit, or from the matching unit, as part of the high-frequency power generator, to the processing container. (Column 2, Lines 40-44) An output terminal of the high-frequency power source 12 is an electrically short-circuited end and an input terminal of the matching unit 30 is an electrically open end. (Figure 2)

It would have been obvious to one of ordinary skill in the art to modify the apparatus taught by Dible, Nakano et al., Quon et al., and Reimer et al. to have the length of the transmission line between the power source and the matching unit be less than one eighth of the wavelength of the high-frequency power signal, and to have an output terminal of the high-frequency power source be an electrically short-circuited end and an input terminal of the matching unit be an electrically open end. The motivation for having the length of the transmission line be less than one eighth of the wavelength of the high-frequency power signal, as taught by Zhao et al. (Column 4, Lines 3-11), would have been to allow for the substitution of a relatively inexpensive, compact, reliable fixed matching unit for the conventional variable matching unit, which can be more expensive and less reliable. The motivation to have an output terminal of the high-frequency power source be an electrically short-circuited end and an input terminal of the matching unit be an electrically open end, as taught by Zhao et al. (Column 4,

Line 63 - Column 5, Line 9), would have been to allow for the inclusion of comparator circuitry to adjust delivered power as measured at the electrically open end of the matching unit by comparison with a desired power 38, which is illustrated in Figure 2 to be set relative to ground (electrically short circuited end).

Setting the length of the transmission line to be less than one eighth of the wavelength of the high-frequency power signal translates to the length being less than $3\lambda/8$, λ being a wavelength of the third harmonic wave of the high-frequency electric power. (The frequency of the third harmonic is three times the frequency of the applied high-frequency power signal, and thus the wavelength of the third harmonic is also three times the wavelength of the applied power signal.) Having the length of the transmission line be less than $3\lambda/8$ meets the limitation that it be less than $3\lambda/4$ (a length where a resonance state of a third harmonic wave of the high-frequency electric power may be generated).

5. Claims 4, 5, 7, 14-16, 18, 19, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dible in view of Nakano et al., Quon et al., and Reimer et al. as applied to Claims 1 and 11, and further in view of U.S. Patent 6,703,080 to Reyzelman et al.

The teachings of Dible, Nakano et al., Quon et al., and Reimer et al. were discussed above.

In regards to Claims 4, 14, and 16, Dible teaches that the first high frequency electric power source 206 comprises a first high-frequency electric power generating part that generates the first high frequency electric power when direct current power is

supplied thereto from a direct current power source 220 that converts AC power into DC power. (Column 7, Lines 24-56)

In regards to Claims 4, 5, 14-16, 19, and 22, the combination of Dible, Nakano et al., Quon et al., and Reimer et al. does not expressly teach an output filter provided between the transmission line and the first high-frequency electric power generating part, having an output terminal connected to the transmission line as an electrically short-circuited end, that selectively allows the high-frequency electric power from the high-frequency power generating part to pass through; or a circulator, connected between the high-frequency generating part and the filter, that allows a forward wave from the high-frequency power generating part to pass through and absorbs a reflected wave from the matching unit.

Reyzelman et al. teaches that a high-frequency power source 14 includes a filter (diplexer comprising low pass filter 52 and high pass filter 58) connected to the transmission line as an electrically short-circuited end (Figure 3B), that selectively allows the high-frequency electric power from the high-frequency power generating part to pass through; and a circulator 32, connected between the high-frequency generating part and the filter, that allows a forward wave from the high-frequency power generating part (power indicated at 28) to pass through and absorbs a reflected wave from the matching unit 60. (Figure 3B; Column 7, Lines 13-21; Column 9, Lines 3-30)

It would have been obvious to one of ordinary skill in the art to modify the combination of Dible, Nakano et al., Quon et al., and Reimer et al. to include a filter and a circulator in the manner taught by Reyzelman et al. The motivation, as taught by

Reyzelman et al. (Column 9, Lines 31-34) for including a filter in the manner taught by Reyzelman et al., would have been to decrease the amplitude of reverse signals coming back from the plasma load through the matching unit and reaching the high-frequency power generating part. The motivation, as taught by Reyzelman et al. (Column 13, Line 55 Column 14, Line 3) for including a circulator in the manner taught by Reyzelman et al., would have been to provide isolation and suppression of reflected power caused by interactive plasma impedances that would otherwise degrade stability and reliability of the system.

In regards to Claims 7 and 18, the combination of Dible, Nakano et al., Quon et al., and Reimer et al. as discussed above does not expressly teach that the first frequency is 70 MHz or greater.

Reyzelman et al. teaches the use in plasma processing systems of very high frequency (VHF) power generators, with frequencies of 40-300 MHz (which range overlaps with the claimed range). (Column 1, Lines 50-61)

It would have been obvious to one of ordinary skill in the art to modify the teachings of Dible, Nakano et al., Quon et al., and Reimer et al. in view of the teachings of Reyzelman et al. to use a VHF power generator to supply the first power to the first electrode. The motivation for making such a modification, as taught by Reyzelman et al. (Column 1, Lines 50-61), would have been to obtain better uniformity of ion and radical flux across the wafer, higher productivity, and higher repeatability.

6. Claims 28, 29, 32, and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dible in view of Nakano et al., Quon et al., and Reimer et al. as

applied to Claims 1 and 11, and further in view of U.S. Patent Application Publication 2002/0134508 to Himori et al.

The teachings of Dible, Nakano et al., Quon et al., and Reimer et al. were discussed above in regard to Claims 1 and 11.

In regards to Claims 28, 29, 32, and 33, the combination of Dible, Nakano et al., Quon et al., and Reimer et al. does not expressly teach the claimed features of the first matching unit.

Himori et al. teaches wherein, in a plasma processing system (Figure 1), a matching unit 41 can comprise an input part 64 directly connected to a transmission line 40a, a resonance rod 61 inductively coupled to the input part to provide a high-frequency electric power to a power supply rod, and a variable capacitor 62 connecting the resonance rod 61 to the power supply rod (the line between the variable capacitor 62 and electrode 21). (Figure 2a, Paragraph 64)

It would have been obvious to one of ordinary skill in the art to alternatively substitute the matching unit of Himori et al. for the first matching unit in the combination of Dible, Nakano et al., Quon et al., and Reimer et al., as an art-recognized equivalent matching means for a high-frequency power. An express suggestion to substitute one equivalent component or process for another is not necessary to render such substitution obvious. *In re Fout*, 675 F.2d 297, 213 USPQ 532 (CCPA 1982).

Response to Arguments

7. Applicant's arguments filed 24 May 2011 have been fully considered but they are not persuasive.

In response to Applicant's argument that there is no specific suggestion or teaching in the references themselves to combine their teachings, *KSR International Co. v. Teleflex Inc.,* 550 U.S.--, 82 USPQ2d 1385 (2007) forecloses the argument that a *specific* teaching, suggestion, or motivation is required to support a finding of obviousness. Examiner maintains that one of ordinary skill in the art at the time of the invention would have found it obvious, with a reasonable expectation of success, to combine the teachings of the cited prior art as set forth above to arrive at the claimed invention.

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Maureen Gramaglia whose telephone number is (571)272-1219. The examiner can normally be reached on core hours of 10-5, Monday-Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on (571) 272-1435. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/Maureen Gramaglia/
Primary Examiner, Art Unit 1716